



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

GILBERT'S FABLES.

WANT of sympathy between men of like high character or noble pursuits is not uncommon. Hence it need not perplex us to find Bacon accusing Dr. Gilbert, a fellow countryman and author of "De Magnete," in 1600, of telling "so many fables" in that remarkable first treatise on magnetism. But though his work was thus belittled where it should have received the warmest recognition, Gilbert to-day is universally admitted to have made the new departure from which all electrical chronology dates. He was not only, as Hallam says, the writer of the first notable English work in physics, but the father of experimental philosophy in England; and his airy "fables" have resolved themselves into some of the most solid benefits that science has conferred on mankind. Could Bacon see what has been accomplished through the development of Gilbert's fancies and theories, it would surprise him perhaps not less than to behold himself credited with the plays of Shakespeare.

The results of electrical discovery are, in fact, already so numerous that in dealing with the subject it becomes more and more difficult for the reviewer of growth in this field to do other than generalize. At the International Electrical Exhibition in Philadelphia in 1884 the production and application of electricity required division into no fewer than fifty classes. A few months ago, at the fair of the American Institute, in New York, the use of electricity as a motive power alone found as many special departments; while several inventions embryonic or unknown three years back, were well to the front as objects of curiosity or investigation. Less than almost any other men are electricians inclined to accept Lord John Russell's invitation to "rest and be thankful," or to loaf and invite their souls with Walt Whitman. Never, indeed, has there been in electrical work greater activity than that which has prevailed during the last twelve months, and never before were such

extensive plans in contemplation. It is this very onrush and uplift of inventive genius and practical development that tempts to dithyrambic raptures alike the social reformer who sees in electricity a panacea for every ill, and the speculator who notes with quick eye the new chance offered to play on old credulity. The modern world is altogether of the opinion of Justin McCarthy's utilitarian baronet that "practical science is the great thing," and it is well aware that electric arts are first among those which now secure and enlarge human welfare, as well as promise benefits in the ages yet to run.

Each of the great departments of electrical application has its own interesting story or pertinent moral, and each is a typical exemplification of the rapidity with which, in America, the visionary idea of one hour becomes the prosaic reality of the next. The telegraph was the first of the great electrical successes, and is an old friend of the present generation. Its ten-word tariff has introduced into popular and business phraseology a terseness the furthest removed from grammar and elegance. It is a prime agent in stockjobbing operations and the ready ally of the detective bureau. It is the mainstay of the daily press, whose columns it half fills. Its wires have long been among the strongest ligatures that can unite a nation so widely distributed from sea to sea as ours. It has profoundly affected international relations, provoking from Prince Bismarck the odd complaint that diplomacy has, therefore, ceased to be unctuous. Fit expression, as it is, of this fussy, alert, inquisitive and intense age, it has become hackneyed and commonplace. Yet it has been in use a bare fifty years, for it was only in January, 1838, that Professor Morse completed his rough operative model of the recording electro-magnetic telegraph, and exhibited it in this city.

Early associates of Morse are still living who helped him string his primitive land lines, while Mr. Cyrus Field recalls easily, across a scant quarter of a century, the vivid memories of the failure of the first cables, when hope and funds were both exhausted, and Dr. Holmes apostrophised in caustic verse the mythical De Santy, who insisted throughout that everything was "all right" when there was a well-founded suspicion that something was very decidedly wrong. At the present time a dozen cables span the Atlantic between Europe and America. In 1886 there were six hundred and sixty-seven thousand seven hundred and ten miles of

telegraph wire in the United States, which carried seventy-two million messages; and the aggregate of work done in analogous services, such as police, fire, burglar alarm, stock ticker and district messenger, would show results as large. These figures are in themselves an indication that the interest of the public in the telegraph is now commercial rather than scientific. It is true that progress has recently been made in sextuplexing, and in telegraphy between moving trains, and that telegraphy between ships at sea, through the water, is in the near future; but, after all, the telegraph is, in the sphere of electricity, and compared with later advances, very much like England or Portugal compared with our new Western States. In the one case it is a question of economy, of higher output, of making the most of one's familiar resources; in the other, it is a question of exploitation, of frontier enterprise and of the pre-emption and occupancy of virgin soil. The telegraphic struggles and agitations that arrest public attention belong to Wall street, for those that once occupied the schools and the patent courts have almost all been disposed of. In one direction, however, the telegraph will sooner or later attract notice, and that is as a leading political issue. It has always been somewhat singular that the newspapers most desirous of governmental control of the telegraph should be eager in welcome of any new contestant with the Western Union Company, whether it be Mr. Garrett executing ancestral schemes, or Mr. Mackay backed by mines of silver. Five years of uninterrupted monopoly by the great corporation whose appetite for rivals has grown by what it feeds upon, might settle the controversy for ever.

The telephone, though a great and distinct invention, came in an evolutionary way. The use of the telegraph had not only created the want but had pointed to the means of supplying it, and when the crude instrument was brought out, its value was immediately recognized in technical circles, in spite of the remark of one cultured organ of public opinion in New York that there was no field of usefulness for it. Within a decade, however, it has become the most patronized means of urban intercommunication, and its "extra-territorial" or long-distance lines are paralleling telegraph circuits in every direction. Last year no fewer than 312,605,710 exchange "connections" were made, and nearly 3,000,000 messages passed over extra-territorial wires. The exchange work is growing at the rate of 25,000,000 conversations

per annum, and it is now nothing unusual to bring together the wires of five or six thousand subscribers in a single switch-board. Protected by exclusive patents, which remain in force after tremendous litigation and unscrupulous onslaught by politicians, the telephone industry constitutes a strong and ramified monopoly in which the parent company and its sub-organizations are partners. Should the fundamental patents be broken before their normal expiration, there would begin a desperate fight for the prize of exchange business, but it seems likely that this would rest in the hands now holding it. The management of the telephone system, as a whole, has been carried on with consummate skill, and as the nature of the service requires that in any given city the customers shall all be within reach of each other, it is natural that the capital stock and investment of over \$50,000,000 should be able to maintain against all competition the 1,182 exchanges and branches now in operation. This is as it may be, and is a consideration for those advocating a national telegraph system. It would be useless to buy up or control that without securing the telephone. Perhaps both will remain private property, but be placed under the supervision of a body similar to the Railway Commission now enforcing the provisions of the Interstate Commerce law. Outside of the exchange system, however, a great field of employment will some day be found for the telephone in supplementing or even supplanting the present annunciator system in hotels, factories and offices; and in domestic life it will replace the ineffectual bell.

It is not impertinent to point here to the striking contrast between the development of the telephone in America and in Europe. There are in America 147,000 exchange subscribers, and the instruments in use number 353,518. Returns made lately show that in Holland, Belgium, Italy and Russia there are only 19,000 telephone subscribers. Thus in America with a population of 60,000,000, the proportion is one in 340; in the large section of Europe above named, with a population of 136,000,000, it is one in every 7,158. New York and Brooklyn have as many telephones as all Italy; Chicago is on an equality with Russia; Boston is abreast of Holland. If use of the telephone be taken, instead of the familiar standards, as a test of civilization, America is so far ahead as to place Europe in the ranks of barbarism. The explanation is hard to determine. In Europe the telephone is controlled

by the various governments, and that may be one reason, though it is not an argument that will commend itself in all quarters.

Scarcely had the telephone been accepted as a boon, before the rays of the first practical commercial electric light were perceived. Previous to 1879, the public knew of electric lamps only by name, and with that year begins the present period of electrical engineering which will be a notable and marked feature of the last part of the nineteenth century. Up to that time, save in electro-plating, large currents were beyond the skill of the electrician, either to produce or to handle for general consumption. Now, every night, scores of huge central stations throw on their wires currents representing as much as 1,500 horse-power, as well as illustrating on a gigantic scale the correlation of forces and the conservation of energy. Beginning its career amid wild and disastrous speculation, the electric light has survived the reckless booming of its most enthusiastic friends and the violent opposition of its most savage enemies. The capital invested in the United States in the manufacture of electric lighting apparatus and the sale of electric light locally is already equal to that in telegraphy and telephony together, reaching over \$150,000,000. A thousand lighting companies and three thousand private plants have in operation 200,000 arc lights and nearly 1,500,000 incandescents, and the work is only in its inception. In New York alone three new stations each of 2,000 horse-power are contracted for or in course of construction, and the designs have been made for as many more. Noteworthy, too, is the change of front on the part of the gas companies, over a hundred of which have come to the conclusion that they can sell silk as well as calico, and have equipped to fill the demand for the new style of goods.

The reasons for the popularity of the electric light are not far to seek. On the public streets and in open areas, the arc light has proved a convenience to good citizens and a terror to evil doers. Few more cheerful or beautiful sights can be seen than the tower, like a radiant "sister of the day," as Shelley phrased it, holding aloft through storm and calm its torch of living fire, or the long lines of insistent white stars that now begirdle the thoroughfares of our most progressive cities. The production of arc lights has been so greatly improved and cheapened that their use is now universal. Mayor Hewitt has proposed their adoption in New

York for all the streets, on the ground that they "tend very greatly to the prevention of crime and the preservation of good order in the city;" and exclusive lighting of the streets in this way is now under practical consideration also in Chicago and Philadelphia. The future of the arc light is well assured.

The incandescent electric light, the little bulb in which the resistance offered to the passage of the current causes the carbon filament to glow brightly in the vacuum, is now being introduced at a remarkable rate. Its vogue may be accounted for on a variety of grounds. The following table is one of them :

Illuminant.		Cubic feet of oxygen consumed.	Cubic feet of air consumed.	Cubic feet of air vitiated.	Cubic feet of carbonic acid produced.	Heat produced in one pound of water raised 1° F.
12	candle power of gas.....	5.45	17.25	345.25	3.21	278.6
12	" " " oil.....	6.81	34.05	484.05	4.50	361.9
12	" " " tallow candle.....	12.00	60.00	933.00	8.73	505.5
12	" " " electric incandescent lamp.....	None.	None.	None.	None.	13.5

The insurance companies have marked their appreciation by lowering premiums wherever this light is used, and the decorators of the modern House Beautiful have hastened to save their productions by employing it, and to develop its æsthetic possibilities. In his charming little work on "The Library," Mr. Andrew Lang, by way of earnest advice, says: "The book collector must avoid gas, which deposits a filthy coat of oil that catches dust;" and it is well known that many libraries are now open at night with the help of electric light that formerly were accessible only in the daytime. One can hardly enter a fine new building anywhere without observing the incandescent lamp or the little wires that betoken its coming. The only objection to this light—its cost—grows fainter every year. In a large number of places it is sold at a profit in direct competition with the cheapest gas, and the wholesale way in which it is now supplied also tends to equalize the economic conditions. One effect of its introduction, as exemplified by figures gathered from a score of towns and cities in eight States, is a reduction of 26 per cent. in the price of gas to the con-

sumer. Moreover, the percentage of candle-power to horse-power is steadily gaining, and is far from its ultimate limits. Electrical ingenuity is just at present striving chiefly to simplify and cheapen the methods of distributing the current to the lamps, and notable results have been gained. That the change from gas to electricity is going on cannot be denied, but the significance of the revolution is not generally understood. Take merely its relation to mechanical engineering. Expert figures on incandescent lighting show that a central station plant at full capacity should be equal to one 16 candle-power lamp per capita of population. Five years hence 18,000,000 people will be living in cities and towns of 4,000 and upward. To supply them would require an output of 11,000 lamps, and of 1,000 horse-power of boilers, engines and dynamo-electric machines every working day from now until 1892. The gain in 1887 justifies the sober acceptance of such calculations as not far from the mark.

If the utility of the distribution of electric current were arrested at this point, it would not be quite so difficult to estimate its possibilities, but already it is evident that lighting is but one department to be considered. Many minor employments for the current from lighting circuits have already been found, including the boiling of kettles and the heating of foot warmers, where the kettle and the warmer are simply substituted for the lamp. But all such work sinks into utter insignificance when compared with that which has opened up in the use of electricity as a motive power. The central station superintendent can now assert, in the language of James Watt to King George : " I have what all your Majesty's subjects want—power." The citizen who turns on the water tap or lights his gas realizes that he is drawing on a reservoir practically inexhaustible, but he has not yet mastered the idea that the wires running by his door bring to his service an unwearying agent that, in readiness and variety of accomplishment, is a veritable Jack-of-all-trades, whose ability rises in exact proportion to the demands made for performance. The electric motor as an efficient machine has not been known much more than two years, but the rapidity of its introduction has been nothing short of marvelous. The first American statistics on the subject, collected recently by the writer, show that there are now in use in this country at least ten thousand electric motors, and that at the present rate of demand the number will be doubled within six

months. One type of motor alone is now employed in over one hundred and twenty different industries. The work given these machines, a large number of which are from one up to fifteen horse-power, and are driven by current from a central station which at night feeds hundreds of electric lights on the same wires, is not a little striking and amusing. One in a livery stable operates an elevator, pumps water and brushes down the horses. Another is used to squirt colors on photographs. A third is driving a large factory where scores of its fac-similes are made daily. Over a dozen are already on the presses of daily papers. One operates the machinery of a knitting mill where two hundred and fifty hands are employed. Hundreds are at work in connection with fans, sewing machines, coffee mills, ice cream freezers, church organs, boatblacking brushes, freight and passenger elevators, dental lathes, jewelers' tools and the like. Curious instances of the repeated conversion of current into mechanical energy and back again are to be found in the use of motors to drive electro-plating machines, or the dynamos which now, instead of chemical batteries, furnish current in large telegraph offices.

In a word, the electric motor has won its place and laid hold on the future. It has begun a tremendous revolution in the mechanical world. It has distanced other small motors, including the steam engine. A leading mechanical engineer has frankly avowed his opinion that up to fifteen horse-power the electric motor must have the preference over other power apparatus, and his views are more than confirmed by the willingness of power users to pay three and four times the price for the electric motor that they give for the small steam engine. With the electric motor no coal has to be brought in or dirt carried away. No water supply is needed. The engineer is dispensed with. No heat is created. Insurance is lowered. Space is economized. The motor that drives the presses of a daily paper in Detroit has been standing and working on the case it was shipped in. The wires that carry the current may pass through the keyhole, down the chimney, or in by the window frame. In the morning the turn of a switch puts the motor in operation, and at night, with another turn, it ceases to work so quickly that a minute later no one could tell it had been running. The tendency, moreover, is toward the use of larger motors, even above twenty-five horse-power. The average charge per horse-power throughout the country is about \$100 per annum, and on this basis,

motors of any size, deriving current from central stations, compete easily with any other kind of appliance. Recent investigations go to prove also that in the distribution of water powers, the electric motor is unsurpassed ; that even in large mills it may be more economical to convert the water power into electric current in the basement, for driving motors on the various floors, than to connect the turbine directly with long lines of heavy shafting in the usual way. With electric motors the town or mine or factory to be furnished with power may be miles above the plant that generates the current, literally causing the water to do work by returning upward to its source.

Need we wonder that this matter promises to engross the thoughts of the physicist, the mechanic, and the social philosopher ? At the meeting of the National Electric Light Association in Boston last August, the mayor of that city expressed the belief that the electric motor would enable the people there to build up a great many small industries that had been neglected. The same impression is entertained in other cities by many who see that owing to the great flexibility of the system and its easy subdivision of power, it is no longer necessary to concentrate skilled producers within a small and costly space. August Bibel, the German socialist, in his work on "Woman," goes even further, and asserts that electric power is to take the first place in wiping out the "bourgeois world," clearing the road for the socialized community, and "contributing enormously to the amelioration of human conditions of existence." The motor will certainly tend to lighten labor. It is likely to assist by its handiness for domestic purposes, in settling the vexed "servant girl question." But it seems probable that the struggle which is naturally arising for the control in each place of this service, will do much to lessen the blessings counted by the optimist as within reach of the toilers.

There is yet another sphere for the electric motor to fill: that of street railway propulsion. The electric railway is still a novelty, but in the United States and Canada to-day twenty-two such roads are in operation carrying passengers at the rate of between five and ten millions annually ; fifteen are in course of construction ; contracts have been made for nearly twenty more, and many are projected. One of the roads building will have forty electric cars. This all means that the street railway is being revo-

lutionized by electricity as much as are industries requiring stationary motors. Animal power is far too costly in comparison with either the cable system or the electric system, between which the competition for urban traffic now lies. Out of the 120,000 horses on street car lines, 20,000 become practically useless every year. The huge stables are far too often an eyesore and a nuisance. The plant generating current for the motors on the line can be paid for out of the economy on real estate, and in every instance, of test, electricity has been demonstrated to be cheaper than animal power by from thirty to fifty per cent. With electricity, there is a remarkable range of choice as to method. The motor can be placed anywhere on the car, and the current for it is conveyed by overhead wires, by a conduit, by one of the ordinary rails, or is derivable from storage batteries under the seats. The conduit and the storage battery methods will prevail for large cities, and for both an economy averaging from ten to twenty per cent. over the cable is claimed. Time will, it is believed, justify electricians in their estimates. Meanwhile an electric railway has been established in highly successful operation in a large Boston sugar refinery, and one in a Pennsylvania coal mine. Steam, though becoming more and more objectionable for motive purposes in cities, may, however, enjoy a monopoly on the large railroads indefinitely. The operation of the New York Central Railroad by electricity is a task which no man feels called upon to grapple with at present.

In many ways, nevertheless, electricity is gaining a foothold on the steam railroad. Its use in train dispatching and signaling is an old story, but it has also recently been adopted very extensively for train lighting, and the resort for this service is again made to storage batteries. This year will be memorable in American electrical annals for the renewed attention paid to storage. The batteries now furnished return eighty per cent. of the current with which they have been charged, and though they have still to undergo radical improvements, they are already engaged in much practical work. The manner in which they assist in the utilization of "waste powers" stamps them as among the most noteworthy innovations of this era.

It has long been a devout wish of the electrical investigator or inventor to hit upon some method of obtaining electricity direct from fuel. This question may not seem to be as much within the

range of "practical politics" as that of putting the wires underground, but it is more fascinating to the electrical mind, and the endeavors to settle it are unceasing. Public attention has just been drawn to one invention in which the alternate heating and cooling of magnetic metal in front of a magnet causes rotation and produces a current; and the eagerness with which several inventors have come forward to claim priority betrays the general interest in the subject. Similar efforts are also being made to produce current directly from fuel, in this way, with a battery, and one of the latest devices is a cell in which coal is used as the positive electrode. Early advances along this line of research are to be looked for. A number of earnest men, who, for passionate love of experiment may be classed with Faraday, are devoting themselves to the study. The selenium cell, turning sunshine into current; the pyromagnetic generator, like its fore-runner, the thermopile, converting heat into electricity, and the cell in which coal is actually consumed—are the first fruits of their quest.

And so one might go on. As Dr. Priestley reflected a hundred years ago: "It may be said that there is a *ne plus ultra* in everything, and therefore in electricity. It is true, but what reason is there to think that we have arrived at it?" To-day we can only echo Priestley's words. What has been achieved tells us that the greater lies before. The electrician proposes to himself the navigation of the ambient air and the exploration of the deepest sea. He is hastening the time when hand-written correspondence between persons hundreds of miles apart will no longer depend on slow mails; and when seeing by electricity, as much as speaking by it, will be a matter of every day experience. His skill is simplifying the arts of peace and complicating the artifices of warfare. He has found new cures for physical ailments, and his magnet even gives relief, it is said, to minds diseased. Thus, a foremost exponent of modern science, he is ever presenting to the world new problems in chemistry, mechanics, politics, and ethics, and is himself reaching their solution.

THOMAS COMMERFORD MARTIN.